The invention in which an exclusive right is claimed is defined by the following:

1. A method for controlling an element that is part of a system so that for an instance in which it is necessary to reposition the element, the element is moved between a first position and a second position during a transition-time interval, and so that the element only moves during the transition-time interval and is precisely positioned both immediately before and after the transition-time interval, comprising the steps of:

(a) providing a model of the system;

(b) using the model for characterizing internal dynamics of the system in which energy applied to the system outside the transition-time interval is hidden so that the element does not move, other than during the transition-time interval;

(c) for a selected optimization criterion, determining optimal internal states at a beginning and an end of a movement of the element between the first position and the second position; and

(d) based upon the optimal internal states, determining an optimal control input signal for a transition-interval input, and at least one of a pre-actuation input and a post-actuation input acting on the element to cause the element to move from the first position to the second position so as to achieve the selected optimization criterion, wherein the pre-actuation input applies energy to the system before the transition-time interval, the post-actuation input applies energy to the system after the transition-time interval, and the transition-interval input applies energy to the system during the transition-time interval.

2. The method of Claim 1, wherein the selected optimization criterion is to cause the element to move between the first position and the second position with substantially a minimum input energy.

3. The method of Claim 1, wherein the selected optimization criterion is to cause the element to move between the first position and the second position in substantially a minimum transition-time interval.

4. The method of Claim 1, wherein the pre-actuation input is uniquely specified in terms of an unstable internal state component.

5. The method of Claim 4, wherein the post-actuation input is uniquely specified in terms of a stable internal state component, and wherein the unstable internal state component and the stable internal state component are the only components of boundary states for the first position and the second position that can be varied to ensure that the element does not move as a result of the energy applied to the system other than during the transition-time.

6. The method of Claim 1, wherein the control input signal is defined as a function of a transition state difference related to the difference between the first position and the second position.

7. The method of Claim 1, wherein at least one of the pre-actuation input, the post-actuation input, and the transition-interval input comprises a periodically varying signal at one or more frequencies selected to produce a force that acts on the element without causing the element to move prior to or after the transition-time interval.

8. The method of Claim 1, further comprising the step of applying an input signal to move the element during the transition-time interval, as well as the post-actuation input after the transition-time interval, but not the pre-actuation input before the transition-time interval.

9. The method of Claim 1, further comprising the step of applying an input signal to move the element during the transition-time interval, as well as the pre-actuation input before the transition-time interval, but not the post-actuation input after the transition-time interval.

10. The method of Claim 1, wherein the element comprises a read/write head of a nonvolatile memory device that is moved between the first position and the second position to provide access to different portions of a memory medium.

11. The method of Claim 1, wherein the element is included in a nonlinear system.

12. The method of Claim 1, wherein the element is moved between the first position and the second position to carryout a function, said function comprising one of:

(a) scanning a surface;

(b) reading data;

(c) writing data;

(d) positioning the element to implement a process;

(e) positioning the element to access a desired material;

(f) controlling a process as a function of a position to which the element is moved;

(g) fabricating a component by moving the element; and

(h) controlling operation of the system in which the element is included, as a function of a position to which the element is moved.

13. A memory medium storing machine readable instruction for carrying out the steps of Claim 1.

14. A controller for moving an element that is part of a system during a transition-time interval, to achieve a selected optimization criterion, comprising:

(a) a memory in which machine instructions are stored; and

(b) a processor that is coupled to the memory, said processor executing the machine instructions to carry out a plurality of functions, including:

(i) accessing a model of the system;

(ii) using the model for characterizing internal dynamics of the system in which energy applied to the system outside the transition-time interval is hidden so that the element will not move other than during the transition-time interval;

(iii) for the selected optimization criterion, determining optimal internal states at a beginning and an end of a movement of the element between the first position and the second position; and

(iv) based upon the optimal internal states, determining an optimal control input signal for a transition-interval input and at least one of a pre-actuation input and a post-actuation input acting on the system to cause the element to move from the first position to the second position so as to achieve the selected optimization criterion, wherein the pre-actuation input applies energy to the system before the transition-time interval, the post-actuation input applies energy to the system after the transition-time interval, and the transition-interval input applies energy to the system during the transition-time interval.

15. The controller of Claim 14, wherein the selected optimization criterion used causes the element to move between the first position and the second position with substantially a minimum input energy.

16. The controller of Claim 14, wherein the selected optimization criterion used causes the element to move between the first position and the second position in substantially a minimum time.

17. The controller of Claim 14, wherein the pre-actuation input is uniquely specified in terms of an unstable internal state component.

18. The controller of Claim 17, wherein the post-actuation input is uniquely specified in terms of a stable internal state component, and wherein the unstable internal state component and the stable internal state component are the only components of boundary states for the first position and the second position that can be varied by the controller to ensure that the element does not move as a result of the energy applied to the system other than during the transition-time.

19. The controller of Claim 14, wherein the control input signal is defined as a function of a transition state difference related to the difference between the first position and the second position.

20. The controller of Claim 14, wherein at least one of the pre-actuation input, the post-actuation input, and the transition-interval input comprises a periodically varying signal at one or more frequencies selected to act on the element without causing the element to move prior to and after the predefined interval of time.

21. The controller of Claim 14, wherein the machine instructions cause the processor to apply an input signal to move the element during the transition-time interval, as well as the post-actuation input after the transition-time interval, but not the pre-actuation input before the transition-time interval.

22. The controller of Claim 14, wherein the machine instructions cause the processor to apply an input signal to move the element during the transition-time interval, as well as the pre-actuation input before the transition-time interval, but not the post-actuation input after the transition-time interval.

23. The controller of Claim 14, the processor produces an output signal adapted to drive a read/write head of a nonvolatile memory device that is moved between the first position and the second position to provide access to different portions of a memory medium.

24. The controller of Claim 14, wherein the processor is adapted to produce a non-linear output signal.

25. The controller of Claim 14, wherein a control function implemented by the controller comprises one of:

(a) scanning a surface;

(b) reading data;

(c) writing data;

(d) positioning an element to implement a process;

(e) positioning an element to access a desired material;

(f) controlling a process;

(g) fabricating a component; and

(h) controlling operation of a system in which the element is moved from time-to-time.

26. A method for moving an element that is part of a system, between a first position and a second position during a transition-time interval, to achieve at least one of a minimum transition-time interval and a minimum energy for moving the element between the first position and the second position, comprising the steps of:

(a) determining a relative degree of the system;

(b) finding an inverse input for the system;

(c) selecting a transformation matrix to convert system equations that define the system, into an output tracking form;

(d) transforming the system equations into the output tracking form;

(e) decoupling internal dynamics of the system to produce decoupled internal dynamics;

(f) computing parameters for the decoupled internal dynamics; and

(g) determining an optimal output-transition solution as a function of the parameters, for defining an optimal control input for adding at least one of a pre-actuation energy and a post-actuation energy to the element, without causing movement of the element other than during the transition-time interval.